

When the solar eclipse began at about 4:35 p. m. the cirrus and cirro-stratus clouds covered 0.4 of the sky and 0.2 more were covered by cumulus and cumulo-nimbus clouds. A large cumulo-nimbus in the north to north-northwest kept growing backward as fast as its top was blown eastward, and time and again its rising domes would be shrouded for a few minutes in delicate scarf clouds. Local movement in and under the cirro-stratus clouds resulted in occasional appearances of cirro-cumulus waves or patches. By 5 p. m. the amount of cirro-cumulus was about 0.1, if all the scattered patches could be added together. In the northwest to east, under the shadow of the top of the cumulo-nimbus centering in the north, a row of alto-cumulus began to form at 5 p. m. First these were smooth, isolated caps or patches, but when more rapid formation began at 5:20 p. m. they spread, and at the time of their maximum extent and thickness, 5:55 p. m., these clouds formed practically a continuous streak or roll of heavy alto-cumulus or strato-cumulus, covering about 0.1 of the sky. The amount of cirro-cumulus was variable. The cirro-stratus became somewhat thicker, perhaps only because of its movement, which brought thicker parts over. From 5:15 to 6:05 p. m. the sky was 0.9 covered, and at 5:45 p. m., 10 minutes after the maximum of the eclipse, the sky was almost totally overcast. The lowest temperature came 10 minutes later than this. From 5:47 to 6:08 p. m., in spite of the dimmed sun, there were arcs of both 22°- and 46°-halos, and, momentarily, a portion of a circumzenithal arc was seen. From 5:22-25 p. m., there was a third of a double rainbow in the south-east.

As the sun slowly emerged from behind the moon, the cloudiness gradually decreased, the cirro-stratus became thinner, the alto-cumulus gradually disappeared, and the cumulus clouds were rejuvenated. At the end of of the eclipse, about 6:38 p. m., the cirro-stratus and cirro-cumulus clouds occupied a little over half of the sky, and two-tenths more were covered with cumulus and cumulo-nimbus.

As the sun got low, the shadows in the northeast became heavy; and the alto-cumulus streak began to reappear at 7 p. m. A few minutes later the sun set behind the top of a cumulo-nimbus cloud. The cloudiness became 0.6 at 7:15 p. m. At that time, cumulo-nimbus or "false" cirrus clouds extended around the northern horizon from the west-southwest to east-northeast. In the west, some heavy masses of falling rain were silhouetted against the low light. When darkness was coming on at 7:30 p. m., the sky was only 0.4 covered—cirrus 0.1, cirro-cumulus 0.2, cumulo-nimbus 0.1, and a few alto-cumulus lenticulars. The heavy cumulo-nimbus clouds were slowly going to pieces; and now some five or six individuals could be distinguished. When the stars came out, some faint outlines of cirro-cumulus and a little cirrus haze could be seen.

The cloud transformations of this day were typical of June days, with "Gulf weather" 100 miles inland. There were some features, however, which may be ascribed to the reduction in sunlight during the eclipse: such as the formation and evaporation of the long line of alto-cumulus clouds, the rejuvenation of the cumulus clouds after the eclipse, and perhaps the increase and decrease of total cloudiness.

NON-INSTRUMENTAL CLOUD OBSERVATIONS, JUNE 8, 1918.

By CHARLES F. BROOKS.

[Signal Corps School of Meteorology at College Station, Tex.]

Ninetieth meridian time.	Level 1.		Level 2.		Level 3.		Levels 4 and 5.		Total cover, tenths.	Remarks.
	Top of false cirrus; snow falling through Level 2.		Base of minor inversion of temperature, 2 (?) km. below Level 1.		Base of minor inversion of temperature, 4 (?) km. below Level 2.		Considerable stratum with uniform (?) tem- perature gradient.			
	Movement from WNW.		Movement from WSW.		Movement from SSW.		L. 4 from SSW. L. 5 from S. to E.			
	Tenths of sky cov- ered.	Kinds.	Tenths of sky cov- ered.	Kinds.	Tenths of sky cov- ered.	Kinds.	Tenths of sky cov- ered.	Kinds.		
A. M.										
6	3+1	Cl.	00	Cl.Cu.	1	A.Cu. & St.Cu.	0	None.	4	Overflow remnants.
7	2+1	Cl.		? (obscured ?).	4	St.Cu. & A.Cu.	0	None.	6	Do.
8	1+1	Cl.	00	Cl.Cu.	0 (?)	None (?).	6	Cu.	7	1st Cu. at 7:25.
9	0 (?)	None (?).	0 (?)	None (?).	0 (?)	None (?).	7	Cu.Nb., Cu.	7	Light rain just after 9.
10	0	None.	0	None.	0	None.	5	Cu.	5	
11	0	None.	0	None.	00	A.Cu.	2	Cu.	2	A.Cu. lenticulars.
11:30	0	None.	0	None.	00+1	A.Cu.	6	Cu.	6	A.Cu. lenticulars and scarfs.
12	0	None.	0	None.	00+1	A.Cu.	7	Cu.Nb., Cu.	7	Do.
P. M.										
12:33-12:38	00	Cl.	00	Cl.Cu.	1+1	A.Cu.	00	Cu.Nb. Cu.	4	Light rain 12:15. Cl.Cu. and A.Cu. lenticulars and scarfs.
1:00-1:05	00+1	Cl.	2+1	Cl.Cu.	1	A.Cu. & St.Cu.	00	Cu.Nb. Cu.	6	St.Cu. overflow from Cu.Nb.
1:30-1:40	1+1	Cl. & Cl.St.	00	Cl.Cu.	1	A.Cu. & St.Cu.	3	Cu.Nb. Cu.	7	Cl.Cu. scarfs. Halo 1:25-40, 45-50.
2:08-2:10	1+1	Cl. & Cl.St.	0	None.	2	A.Cu.	1	Cu.Nb. Cu.	7	St.Cu.: evaporating Cu.Nb.
2:31-2:35	00+2	Cl. & Cl.St.	00	Cl.Cu.	2	A.Cu. & St.Cu.	2	Cu.Nb. Cu.	8	5 showers in sight.
3:02-3:13	00+2	Cl.	0 (?)	None in sight.	3	St.Cu. & A.St.	3 (?)	Cu.Nb. Cu.	9	Some lenticular A.Cu. 4 showers in sight.
3:35-3:40	5	Cl. & Cl.St.	0	None.	1	St.Cu.	3 (?)	Cu.Nb. Cu. (base from east).	8	Light rain, 3:02-3:15. 3 showers in sight. Cu. leaning E. or SE., slow anticyclonic cloud whirl.

NON-INSTRUMENTAL CLOUD OBSERVATIONS, JUNE 8, 1918—Continued.

Ninetieth meridian time.	Level 1.		Level 2.		Level 3.		Levels 4 and 5.		Total cover, tenths.	Remarks.
	Top of false cirrus: snow falling through Level 2.		Base of minor inversion of temperature, 2 (?) km. below Level 1.		Base of minor inversion of temperature, 4 (?) km. below Level 2.		Considerable stratum with uniform (?) tem- perature gradient.			
	Movement from WNW.		Movement from WSW.		Movement from SSW.		L. 4 from SSW. L. 5 from S. to E.			
	Tenths of sky cov- ered.	Kinds.	Tenths of sky cov- ered.	Kinds.	Tenths of sky cov- ered.	Kinds.	Tenths of sky cov- ered.	Kinds.		
P. M.										

ECLIPSE BEGAN ABOUT 4:35.

4:35- 4:40	4	Cl. & Cl.St.	0	None.	?	None noticed.	1	Cu.Nb.	6	Cu. where sun shines. Halo.
4:41- 4:44	5	Cl. & Cl.St. & A.St.	00	Cl.Cu.	?	Do.	1	Cu.	7	Cu.Nb., in N.-NE. and SE.
4:45- 4:49	?	Cl. & Cl.St.	?	Cl.Cu.	?	Do.	1	Cu.	7	Scarfs in north.
4:50- 4:52	7	Cl. & Cl.St.	?	Cl.Cu.	?	Do.	00	Cu.Nb.	8	Cl.Cu. forming, waved from NNW.
4:53- 4:56	6 (?)	Cl. & Cl.St. & A.St.	1 (?)	Cl.Cu.	?	Do.	00	Cu.	8	Scarf on Cu. in S.
4:57- 4:59	6	Cl. (2) & Cl.St. (3) & A.St. (1).	00	Cl.Cu.	?	Do.	00	Cu.Nb.	7	Cu.Nb. in NNW. to E.
5:00- 5:03	4	Cl. & Cl.St.	1	Cl.Cu.	1	A.Cu.	1	Cu.	7	Cl.Cu. increasing. Halo.
5:04- 5:07	?	Cl.St.	1	Cl.Cu.	?	A.Cu.	00	Cu.Nb.	7	4 showers visible. Cu. thicker.
5:08- 5:11	6	Cl. (2) & Cl.St. & A.St.	00	Cl.Cu.	?	A.Cu.	?	Cu.	8	5 showers visible. Cu.Nb. cloud in SE. with false cirrus tops at levels 1 and 2 and shelf at level 3.
5:12- 5:16	5	Cl.St. (4) & A.St. (1).	00	Cl.Cu. (evap.).	1 (?)	A.Cu. (caps).	00	Cu.Nb.	8	
5:17- 5:21	8	Cl.St. (7) & A.St. (1).	00	Cl.Cu.	?	A.Cu.	?	Cu.	8	
5:22- 5:25	7	Cl.St. (6) & A.St. (1).	0	None.	00	A.Cu.	?	Cu.Nb.	9	Rainbow in SE., 1 leg.
5:26- 5:29	8	Cl. & Cl.St. & A.St. (1).	0	None.	00	A.Cu.	1	Cu.Nb.	9	Double rainbow in SE. (southern 1/2). A.Cu. lenticular.
5:30- 5:34	8	Cl. & Cl.St. & A.St. (1).	00	Cl.Cu.	?	A.Cu.	1	Cu.	9	A.Cu. lenticular, some waved. Faint halo still. Swifts going to roost.
5:35- 5:39	8	Cl. & Cl.St. & A.St. (1).	0	None.	00	A.Cu.	00	Cu.Nb.	9	Cu.Nb. in NNW. to E.
							?	Cu.		Cu. flatter.
							?	Cu.Nb.	9	Considerable increase in lenticular. A.Cu. in E.-W. line in N.
							?	Cu.		

ABOUT 5:37; ECLIPSE MAXIMUM—SUN ABOUT NINE-TENTHS COVERED.

5:40- 5:44	8	Cl. & Cl.St.	0	None.	00	A.Cu.	00	Cu.Nb.	9-	Halo continued. Large Cu. growing; small Cu. decreasing.
5:45- 5:49	8	Cl. & Cl.St.	00	Cl.Cu.	00	A.Cu.	00 + 1	Cu.	9+	Cl.Cu. lenticular. Arc of 46° halo appeared above sun at 5:47.
5:50- 5:53	7	Cl. (1) & Cl.St. (6) & A.St.	0	None.	1	A.Cu.	00 + 1	Cu.Nb.	9-	St.Cu. in south A. Cu. increasing.
5:54- 5:58	7	Cl. (1) & Cl.St. (6).	0	None.	1	St.Cu.	00	Cu.		
					1	A.Cu. & St.Cu.	00 + 1	Cu.Nb.	9-	A.Cu. & St.Cu. almost continuous from WNW. to E. 3 showers E.-S., one NNW.-E.
5:59- 6:05	7	Cl. (1) & Cl.St. (6).	00	Cl.Cu.	1	A.Cu.	00 + 1	Cu.	9	Shiny Cl.Cu. lenticulars in N.-NW.
6:06- 6:08	9	Cl. (2) & Cl.St. (7).	00	Cl.Cu.	00	A.Cu.	00	Cu. & St.Cu.	9	Some A.Cu. lentic. 3 Cu.Nb. clouds.
6:09- 6:14	8	Cl. (1) & Cl.St. (7).	00	Cl.Cu.	00	A.Cu.	00	Cu.Nb.	8	Brilliant lenticular Cl.Cu. under sun.
6:15- 6:17	7	Cl. (1) & Cl.St. (6).	00	Cl.Cu.	00	A.Cu.	00	Cu. & St.Cu.	8	Caps and scarfs in N. & E. Cu.Nb. in SSW., and NW.-ENE. 46° halo just gone, parhelia (22°) still present.
6:21- 6:24	8	Cl. & Cl.St.	00	Cl.Cu.	00	A.Cu.	00	Cu.Nb.	8+	Cl.Cu. lenticulars disappearing.
6:25- 6:29	6	Cl.St.	00	Cl.Cu.	00	A.Cu.	00	Cu. & St.Cu.	7	A.Cu. line disappearing. Cl.Cu. lenticulars mostly gone, new rafts formed NE. and W.
6:30- 6:33	?	Cl.St.	00	Cl.Cu.	00	A.Cu.	00	Cu.Nb.	7	Thick Cl.St. decidedly thinner. Some Cl.Cu. forming within Cl.St.
6:34- 6:37	5	Cl.St.	1	Cl.Cu.	00	A.Cu.	00	Cu. & St.Cu.	7-	Parhelia. A.Cu. streak practically gone.

END OF ECLIPSE ABOUT 6:38.

6:38- 6:42	4	Cl.St.	2	Cl.Cu.	00	A.Cu.	1	Cu.Nb.	7	Cl.St. thinner. Some Cl.Cu. above Cl.St.: some new Cl.Cu. below, from WSW.
6:43- 6:49	4	Cl.St. (3) & Cl. (1).	1	Cl.Cu.	00	A.Cu.	1	Cu.Nb.	7	Lower Cl.Cu. thickening. Cu. in S.-W. and N.
6:50- 6:53	4	Cl.	2	Cl.Cu.	0	None.	00	Cu.	7	Cl.Cu. with delicate lavender and green sheen. Large Cl.Cu. cloud. Cloud points cast shadows on remainder of the cloud.
6:58- 7:03	3	Cl.	2	Cl.Cu.	00	A.Cu.	2	Cu.Nb.	7	Cl.Cu. still iridescent. Cu.Nb. in NW.-ENE. and W.
7:08- 7:11	2+1	Cl.	2	Cl.Cu.	00	A.Cu.	2	Cu.Nb.	6	Some new, balled Cl.Cu., with waves from NW.
7:18- 7:22	1+1	Cl.	2	Cl.Cu.	00	A.Cu.	2	Cu.Nb.	5	Snow falling through A.Cu. layer in SSW.
7:27- 7:30	00+1	Cl.	2	Cl.Cu.	00	A.Cu.	(1 1/2) 2	Cu.Nb.	4	Some waves in false Cl.A.Cu. mostly lenticular. 5 or 6 showers visible WSW., NW.xW., NW., N.xW., N.xE., NE.xE.(?)

In the table above, two numbers such as "1+2," indicate that one-tenth of the sky was covered by the form indicated, and that there is every reason to believe that there were two-tenths more of the same cloud form behind a lower sheet, which at the time of the observation actually covers those two-tenths of the sky.

"oo" indicates that the covering is less than about 7 per cent.

It will be noted in certain instances that the total sky cover exceeds the sum of the individual cloud covers indicated. In these cases, there may be two or three forms covering only 5 per cent or less of the sky each, which altogether would make a tenth. It would be inaccurate to designate any one of these forms as covering a tenth of the sky, in order to make the total conform to the total cover.

THE REFLECTING POWER OF CLOUDS.

By L. B. ALDRICH.

(Smithsonian Misc. Col., vol. 69, No. 10, Washington, 1919.)

Measurements of sky brightness were made by the author in cooperation with officers and men of the balloon

school of the Army at Arcadia, Cal., on September 17, 1918. They may be considered a continuation with improved facilities of the measurements already discussed in the *Annals of the Astrophysical Observatory*, Volume II. The author's summary follows:

SUMMARY.

A pyranometer suspended below the basket of an Army observation balloon was used to measure the reflecting power of a level cloud surface practically filling a hemisphere of solid angle. Over 100 determinations were made. The solar air masses ranged from 2.8 to 1.2, and the sky above was cloudless and very clear. A mean value of 78 per cent is obtained. No change of total reflection depending on solar zenith distance is apparent within a range of zenith distance from 33° to 69° . A value of 43 per cent for the albedo of the earth is obtained by revision of the earlier value of Abbot and Fowle (*Annals*, Vol. II, p. 162) which depended on a lower value of cloud reflection based on observations over but a small part of a hemisphere.—H. H. K.

AN IMPROVEMENT IN THE POLE STAR RECORDER.

By B. C. KADEL.

[Dated: Weather Bureau, Washington, Apr. 3, 1919.]

An instrument known as the pole star recorder has been recently completed in the Instrument Division of the Weather Bureau for use at the Weather Bureau observatory at the University of Chicago (see fig. 1). The pole star is not at the true north pole of the celestial sphere, but is about $1\frac{1}{2}$ degrees from it, and therefore appears to move each day about the true pole in a circular path whose diameter is about $2\frac{1}{2}$ degrees. If a camera is pointed toward Polaris, and the shutter is opened after dark and closed before daylight next morning, we shall find on the sensitized plate or film a curved line made by the light from the pole star, provided the sky about the star was clear. When clouds are present all night the plate will be blank, and when the night is one of varying cloudiness, a broken curved line will result (see figs. 6, 7, and 8).

It is evident, therefore, that a camera offers a fairly reliable means of recording cloudiness at night without any complicated mechanical parts, although the portion of the sky about Polaris may not always represent the condition of the sky as a whole. Prof. E. C. Pickering, of Harvard University, is said to have been the first to employ the device, and Mr. S. P. Fergusson¹ published in 1905 a description of an improved form.

Several years ago Prof. C. F. Marvin designed a clock attachment for opening and closing the shutter of the camera at a predetermined time, and provided a circular metallic disk or dial with time graduations cut through it, so that by interposing the disk between the sensitized plate and daylight for a fraction of a second, the time scale might be printed photographically. Orientation of the graduated disk was accomplished each day by reference to the almanac, and it was found that the men assigned to the work were quite liable to error and confusion in setting the disk.

The improvement to be described is directed to render-

ing the orientation of the disk a simple operation, and particularly to making the observer independent of the almanac. The disk (figs. 2 and 3), with the time scale engraved upon it as intended to be reproduced upon the sensitized film, is built into a rotating circular brass frame upon whose periphery is formed a cogwheel with 365 teeth, one tooth for each day in the year. A worm wheel that meshes with the 365-toothed wheel is turned by means of a small thumb screw attached to a shaft that projects within reach of the observer (see fig. 2). The entire device is built into a frame modeled after a standard photographic plate holder.

When the disk has been once properly oriented, it is required merely to turn the thumb screw one complete revolution each day to advance the time scale $1/365$ th of a revolution, and thus bring it into proper relation to the star trail. The record actually made by Polaris in sidereal time may then be read off directly in mean solar time of a standard meridian.

In order that the observer may be able to make the initial setting without reference to the almanac, there has been engraved on the rotating dial opposite selected hours the date on which Polaris culminates at that particular hour (see fig. 3). When the particular hour mark mentioned coincides with an arrow engraved on the nonrotating part of the device at the position corresponding to upper culmination, the dial is approximately correct for the date indicated, probably within the limits of accuracy of the instrument. Final adjustment to the actual date desired is accomplished by turning the thumb screw the required number of revolutions.

A removable circular section of clear glass has been set into the central portion of the space within the time dial, to provide a means of identification of the record. The glass is first smoked, after which the date is stamped on with an uninked rubber stamp, which removes the soot, so that the light may shine through.

The entire time-scale device is inserted between the sensitized film or plate and the lens of the camera in the

¹ Fergusson, S. P.: "The Automatic Polar Star Light Recorder"; *Quart. Jour. Roy. Meteorological Soc.*, 31, 1905, p. 309-313, and *Amer. Meteorological Jour.*, June, 1894, p. 62-64.